NAVAL POSTGRADUATE SCHOOL
Monterey, California

EC 4210 MIDTERM EXAM I 2/4/98

- This exam is open book and notes.
- There are three problems; each is equally weighted.
- Partial credit will be given; *be sure to do some work on each problem.*
- Be sure to include units in your answers.
- *Please circle or underline your answers.*
- Show *ALL* work.
- Do not do any work on this exam sheet.

1	
2	
3	
Total	

Name: _____

1. Consider an acousto-optic beam deflector made of KRS-5. The transducer on the deflector is centered at 80 MHz and has a fractional bandwidth of 40%. Calculate the width of the laser beam that is required if there are to be 1,000 spots from the deflector.

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2. A photomultiplier tube operates at a wavelength of 850 nm with a gain of 10,000. It has a dark current of 1 pA. When this tube is illuminated with 1 μW of unmodulated light, the output current from the photomultiplier tube is 6.8 mA.

   Consider the tube being operated in the direct-detection mode with $m = 1$. Find the power level of the signal that makes the signal-dependent shot noise equal to ten times the shot noise due to the dark current.

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3. Consider an optical prism made of an electro-optic material as shown in the left part of the figure. The material outside of the prism is air. The apex angle of the prism is α. A voltage, V, is applied along the x' direction of the material. Vertically polarized light is incident perpendicular to the face of the prism. It continues through the prism and is incident at the back face of the prism with an incidence angle, α. The back surface of the prism refracts (i.e., bends) the propagation direction of the light through an angle, ϕ.

   Snell's Law governs the refraction of light at an interface. (See the right figure.) The sine of the angle of transmission, θ_t, is given by $\sin\theta_t = n_1 \sin\theta_i / n_2$. For small angles, this can be written as

$$\theta_t = \frac{n_1 \theta_i}{n_2} \,. \tag{1}$$

   (a) When the applied voltage is zero, find an expression for the deflection angle, ϕ_1. (You may use the small angle approximation.)

   (b) When the applied voltage is of value V, find an expression for the deflection angle, ϕ_2, in terms of V and other parameters. (You may use the small angle approximation.)

   (c) Find an expression for the difference in deflection angles, $\Delta\phi = \phi_1 - \phi_2$.

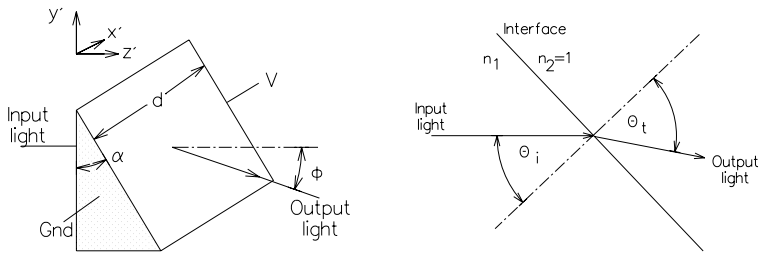

Figure 1: Problem 3.